



Traffic Signal Design Manual

ORIGINATOR Director, Bureau of Highway Operations		2-4-1
CHAPTER 2	Signal Investigation Study	
SECTION 4	Documentation	
SUBJECT 1	Sample Study	

The following study has been prepared as a sample for this manual.

Sample cover letter (Consultant to Region)
Sample memorandum (Region to Central Office)

Sample Investigation Study

- DT1199 Traffic Control Signal Approval Request
- Analysis (Reason/Need for Study/Recommendation)
 - a. Existing Physical Conditions and Control Devices
 - b. Traffic Conditions (see TSDM Subject 2-2-1)
 - c. Warrants met
 - d. Crash History (see TSDM Subject 2-2-2)

Appendix

- Site Map
- Hourly Traffic Volume Counts
- Vehicle Volume Count Graphic Summary Sheet (optional)
- Warrant Analysis Worksheets
- Signalized Intersection Capacity Analysis
- Crash Record Extract
- Collision Diagram (optional)

SAMPLE COVER LETTER
(CONSULTANT TO REGION)

Date

(Region Office)

Re: Signal Investigation Study
S.T.H. XX and C.T.H. YY
Town of Somewhere
Here County

Dear XXXXXX:

Attached for your review and approval is a signal investigation study for the intersection of S.T.H. XX and C.T.H. YY. The proposed installation is requested due to an increase in traffic, accidents, and congestion. In addition, there have been several requests from area residents to consider a traffic signal at this location.

In the fall of 1993 acceleration and deceleration tapers were installed on STH XX. This was an interim improvement prior to a signal being installed.

Traffic signal warrants 1, 2, 3 and 7 as stated in the *Wisconsin Manual on Uniform Traffic Control Devices*, are satisfied for the required number of hours for this location.

A signal capacity analysis was performed based on common signal phasing and timing parameters as described in TSDM Subject 3-2-2, existing turning movement counts, and current intersection geometrics. Results of the analysis (included in the appendix) have determined that the intersection will operate with acceptable levels-of-service, and the expected queues will not exceed intersection storage currently provided or planned for.

We recommend approval of this installation.

Sincerely,
Private Consultant

SAMPLE MEMORANDUM
(REGION TO BUREAU OF HIGHWAY OPERATIONS)

Date:

To: (State Traffic Signal Engineer)

From: (Regional Traffic Engineer)

Subject: Signal Investigation Study
Project ID (number)
S.T.H. XX and C.T.H. YY
Town of Somewhere
Here County

Attached for your review and approval is a signal investigation study for the intersection of S.T.H. XX and C.T.H. YY. The proposed installation is requested due to an increase in traffic, accidents, and congestion. In addition, there have been several requests from area residents to consider a traffic signal at this location.

In the fall of 1993 acceleration and deceleration tapers were installed on STH XX. This was an interim improvement prior to a signal being installed.

Traffic signal warrants 1, 2, 3, and 7, as stated in the *Wisconsin Manual on Uniform Traffic Control Devices*, are satisfied for the required number of hours for this location.

A signal capacity analysis was performed based on common signal phasing and timing parameters as described in TSDM Subject 3-2-2, existing turning movement counts, and current intersection geometrics. Results of the analysis (included in the appendix) have determined that expected queues will not exceed intersection storage currently provided. Based on the analysis, left turn phasing will not need to be provided at this time.

Contracted forces will complete aboveground and underground work. Operations and maintenance of the installation will be at the expense of the Department.

The total estimated cost is \$ __, __. __.

The project will be funded through (state funding source(s)).

We recommend approval of this installation.

DT 1199 – TRAFFIC CONTROL SIGNAL APPROVAL REQUEST

TRAFFIC CONTROL SIGNAL APPROVAL REQUEST

Wisconsin Department of Transportation

DT1199 5/2006 s.86.32(1) Wis. Stats.

Municipality	County
State Trunk Highway	Intersecting Road

Check if connecting highway - Requires authorized municipal and departmental approval below
Approval of installation on the connecting highway system is required under s.86.32(1) Wis. Stats.

The Region requests approval of a traffic control signal at the location indicated above. Traffic volumes, crash experience and physical conditions at the described intersection have been reviewed. A traffic control signal is justified.

Approval Recommended

(Regional Traffic Engineer) (Date)

Approval Granted

(Bureau of Highway Operations) (Date)

TRAFFIC CONTROL SIGNAL INSTALLATION, OPERATION, AND MAINTENANCE AGREEMENT

The municipality identified above agrees to install, operate and maintain a traffic control signal at the specified intersection for the purpose of controlling the flow of traffic.

The following conditions precedent to approval of the signal are acknowledged and accepted by the municipality:

1. The design, installation and operation of the signal will comply with the Wisconsin Manual on Uniform Traffic Control Devices.
2. The cost of maintenance and operation of the signal will be the responsibility of the municipality or in any case will not be an obligation of the Wisconsin Department of Transportation.
3. Parking will be restricted by the municipality at locations on the identified intersecting streets in accordance with the need to provide adequate capacity and normal flow of traffic. Specific restrictions, if needed, are as follows:
4. The municipality, with the approval or at the request of the Department of Transportation, and at the municipality's expense, shall make such adjustments in the equipment and manner of operation of these signals as are deemed necessary for public safety and facilitation of traffic movement.

Yes No Further provisions are stated on the back of this document.
 Yes No Attachments

Agreed on behalf of the Municipality

Agreed on behalf of the Department

(Signature of Authorized Representative for Municipality) (Date)

(Bureau of Highway Operations) (Date)

SIGNAL INVESTIGATION STUDY

MAIN LINE (STH XX) & SIDE ROAD (CTH YY) INTERSECTION

1. REASON/NEED FOR STUDY

The traffic volume in this area has tended to increase rapidly over the last few years. In addition, we have received numerous requests (letters attached), mostly from area residents, to consider the installation of a traffic control signal at the intersection of STH XX and CTH YY. Accidents and congestion are increasing along with the increase in area development and traffic.

2. EXISTING PHYSICAL CONDITIONS AND CONTROL DEVICES

Each of these roadways is a two-lane road with 10-foot shoulders on STH XX and a minimal of 2 to 4 foot shoulders on the CTH YY. The Main Line (STH XX) has 150-ft left-turn bays at the intersection. STH XX has a 55 mph speed limit while CTH YY has 35 mph limits on each side of the intersection. Existing traffic control at the intersection consists of two-way STOP control for CTH YY. New acceleration and deceleration tapers were installed September of 2002 on STH XX as an interim operational improvement prior to a signal being installed.

3. TRAFFIC CONDITIONS

A 16-hour manual traffic count was made at this intersection on Tuesday, October 21, 2003 and Wednesday, October 22, 2003. The results of this traffic count are summarized in Figure 1; the actual count data is included in the Appendix.

4. CRASH HISTORY

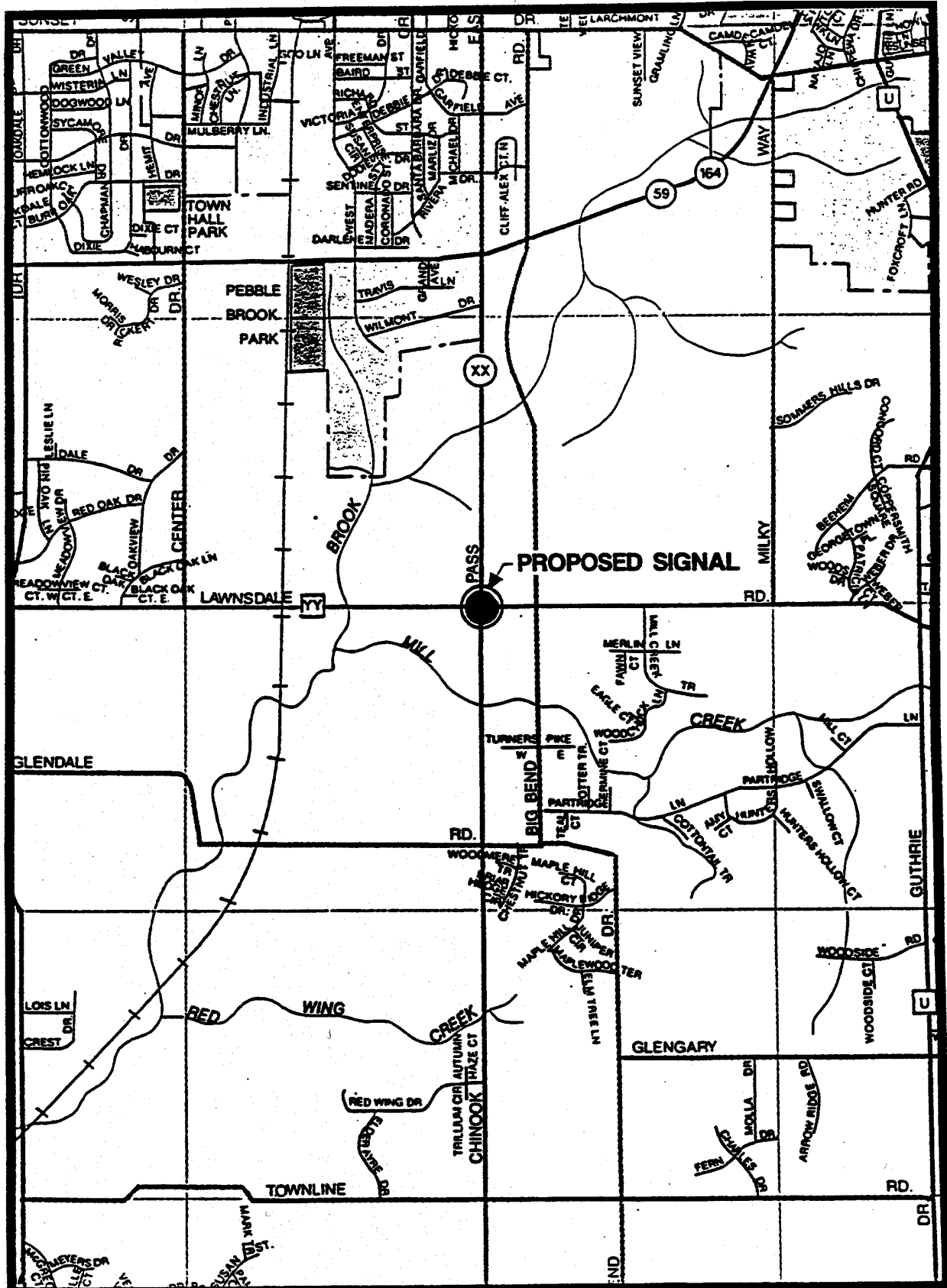
The crash history shows an increase in crashes and a minimum of 5 crashes in a 12-month period which are correctable by installation of a traffic control signal. There was one fatality crash at the intersection.

5. WARRANT MET

The following signal warrants are met and are summarized on the Warrant sheets:

Warrant #1 – Eight-Hour Vehicular Volume	
Condition A - Minimum Vehicular Traffic:	8 hours
Condition B - Interruption of Continuous Traffic:	14 hours
Condition C - Combination of Warrants:	9 hours
Warrant #2 - Four Hour Warrants:	9 hours
Warrant #3 - Peak Hour Warrant:	7 hours
Warrant #7 - Accident Experience:	8 hours

APPENDIX I – SITE MAP



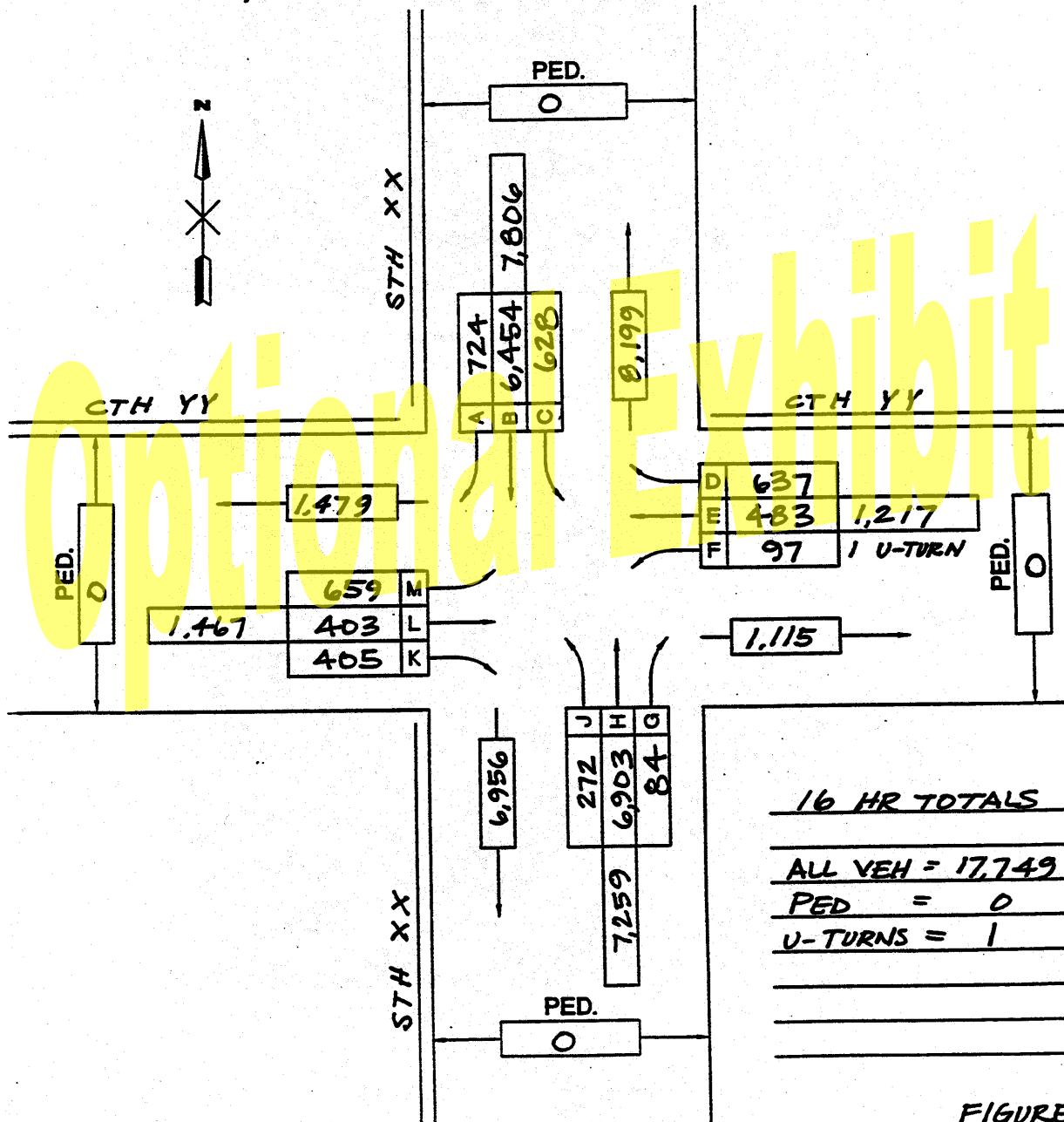
APPENDIX II - HOURLY VOLUME COUNTS

TRAFFIC SURVEY VEHICLE VOLUME COUNT
GRAPHIC SUMMARY SHEET

State of Wisconsin / Department of Transportation

E-T-704-70

DATE 10/20, 21/92 DAY TU, WE TIME 6: AM TO 10: PM SHEET 1 OF 2
 LOCATION: DISTRICT X COUNTY XXXXXX RURAL YES CITY _____
 INTERSECTION STH XX AND CTH YY
 WEATHER SUNNY, COLD ROAD CONDITION DRY OBSERVERS JWB, SJS



APPENDIX II - HOURLY VOLUME COUNTS (continued)

VEHICLE AND U-TURNS VOLUME SUMMARY
 ALL VEHICLES
 EXPANSION FACTOR
 HOUR EXP (12) = 1.0000
 MONTHLY EXP (1M) = 0.0000
 OBSERVER NAME: J. Doe
 PROCESSOR NAME: D. Smith
 Location : S.T.H. XX and C.T.H. YY
 Day and Date: Tues 10-20-92, Wed. 10-21-92
 Weather: Sunny, Cold

Street Name	S.T.H. XX From North			S.T.H. XX From South			C.T.H. YY From East			C.T.H. YY From West			EXPANSION FACTOR			U-Turn	Total																																																																																																			
	L	A	R	L	A	R	L	A	R	L	A	R	N-S	E-W	ALL			N	S	E	W																																																																																															
6-7	14	346	19	379	29	637	6	672	4	18	43	62	83	187	1,051	250	1,301	0	0	0	0	0																																																																																														
7-8	23	324	13	360	23	800	6	829	4	18	48	67	61	35	1,188	224	1,414	0	0	0	0	0																																																																																														
8-9	18	300	20	338	6	487	4	508	4	11	53	67	76	27	845	188	1,031	0	0	0	0	0																																																																																														
9-10	32	286	28	346	10	359	1	370	2	12	46	60	68	26	715	177	892	0	0	1	0	1																																																																																														
10-11	34	289	30	353	6	355	1	362	10	8	25	43	26	23	715	108	823	0	0	0	0	0																																																																																														
11-12	46	344	40	430	7	355	2	365	2	18	30	51	30	12	794	108	902	0	0	0	0	0																																																																																														
12-1 PM	26	340	32	398	12	407	2	421	1	27	31	59	61	29	820	181	1,001	0	0	0	0	0																																																																																														
1-2	37	359	37	433	7	295	1	304	4	25	16	44	20	13	737	91	828	0	0	0	0	0																																																																																														
2-3	34	300	34	367	12	294	24	330	7	23	29	59	30	26	697	131	828	0	0	0	0	0																																																																																														
3-4	35	695	74	804	29	497	16	541	7	44	25	76	66	27	1,345	214	1,559	0	0	0	0	0																																																																																														
4-5	78	728	98	905	38	516	1	558	4	80	66	150	25	27	1,460	227	1,688	0	0	0	0	0																																																																																														
5-6	92	827	95	1,014	42	618	6	666	20	68	59	146	30	34	1,680	232	1,912	0	0	0	0	0																																																																																														
6-7	65	500	81	646	20	499	8	527	15	55	57	127	41	21	1,173	189	1,371	0	0	0	0	0																																																																																														
7-8	42	481	69	592	18	321	2	341	6	41	46	95	28	24	933	162	1,095	0	0	0	0	0																																																																																														
8-9	32	228	41	301	9	224	1	234	4	28	41	73	19	19	535	120	655	0	0	0	0	0																																																																																														
9-10	20	108	12	140	4	229	2	235	4	14	21	39	11	16	378	76	451	0	0	0	0	0																																																																																														
Approach to:	628	6,454	724	7,806	272	6,903	84	7,259	97	483	637	1,217	659	403	15,085	2,684	17,749	0	0	1	0	1																																																																																														
Departing From	8,200																1,115				1,478				15,156				2,593				17,749																																																																																			
Approach	910																8,326				934				10,070				351				8,905				108				9,364				126				623				822				1,570				850				519				622				1,892				19,434				3,462				22,898				0				0				1				0				1				0				1			
Departing	10,578																8,974				8,974				1,438				1,907				19,551				3,345				22,896				0				0				1				0				1				0				1				0				1																																							

APPENDIX III – WARRANT ANALYSIS WORKSHEETS

Wisconsin Department of Transportation
Traffic Signal Warrant Summary Sheet

70% RURAL

The Worksheet(s) attached are provided as an attachment to the Engineering Investigation Study for:			
Intersection:	STH XX & CTH YY	Date:	5/8/04
County:	XXXXXX		
Town	XXXXXX		
Village			
City			
Major Street	STH XX	Critical Approach Speed	55 Lanes 1
Minor Street	CTH YY	Critical Approach Speed	35 Lanes 1

THIS INTERSECTION IS ANALYZED FOR RURAL WARRANTS. COMMENTS:

Note: The warrants for rural areas (70% of urban warrant) are used when the 85% speed on the major street exceeds 40 m.p.h. or when the intersection lies within the built-up area of an isolated community having a population of less than 10,000.

THE ANALYSIS IS BASED ON COUNTS CONDUCTED ON	10/21 & 10/22	, 20 03	, T, W	FROM	6:00	A M	TO	10:00	A M
	DATES		DAYS			M			M

50% Right Turns Included

Warrant Evaluation Summary

YES/NO/NOT EVALUATED

- Warrant 1** Eight-Hour Vehicular Volume YES
- Condition A Minimum Vehicular Volume YES
- Condition B Interruption of Continuous Traffic NO
- Condition C Combination: 80% of A and B YES
- Warrant 2** Four Hour Volume YES
- Warrant 3** Peak Hour Volume NOT-EVALUATED
- Warrant 4** Pedestrian Volume NO
- Warrant 5** School Crossing NO
- Warrant 6** Coordinated Signal System NO
- Warrant 7** Crash Experience YES
- Warrant 8** Roadway network NOT-EVALUATED
- Left Turn Conflict Analysis NOT-EVALUATED

This analysis was conducted by:

James C. Doe

(Name)
Private Consultant

Agency)
10/29/03

(Date)

TRAFFIC SIGNAL WARRANTS ANALYSIS FORM

Sheet 1

County: XXXXXX		Date: 5/8/04	
Town Village City	XXXXXX		
Major Street	STH XX	Critical Approach Speed	55 Lanes 1
Minor Street	CTH YY	Approach Speed	35 Lanes 1

Volume Level

1. Critical speed of major road traffic > 40 mph : Yes No
2. In built-up area of isolated community of < 10,000 pop.: Yes No
- If Question 1 or 2 above is answered "Yes" then use "70%" volume level: 70% 100%

WARRANT 1 – Eight-Hour Vehicular Volume

Warrant is satisfied if Condition A or B is "100 % satisfied." Warrant also satisfied if Condition C (80% of A and B) is satisfied.

8 Highest Hours								
Hour	5-6p	4-5p	3-4p	7-8a	6-7p	6-7a	7-8p	8-9a
Major Road Both App. vph	1680	1460	1345	1189	1173	1051	933	845
Minor Road High App. vph	232	227	214	224	198	250	162	186

Record hours where condition is met and the corresponding volumes in boxes provided. Condition is 100% satisfied if the minimum volumes are met for eight hours.

Condition A – Minimum Vehicular Volume

(volumes in veh/h)	Minimum Requirements (80% Shown in Brackets)			
	1		2 or more	
Approach Lanes:				
Volume Level:	100%	Hours	100%	Hours
Major Road-Both	350	16	420	
Approaches	(280)	16	(335)	
Minor Road-	105	8	140	
Highest Approach	(85)	9	(110)	

100% Satisfied: YES
80 % Satisfied: YES

Condition B – Interruption of Continuous Traffic

(volumes in veh/h)	Minimum Requirements (80% Shown in Brackets)			
	1		2 or more	
Approach Lanes:				
Volume Level:	100%	Hours	100%	Hours
Major Road-Both	525	15	630	
Approaches	(420)	15	(505)	
Minor Road-	50	14	70	
Highest Approach	(40)	15	(55)	

100% Satisfied: NO
80 % Satisfied: NO

Condition C – Combination of Condition A and B: Condition A and B Both 80% Satisfied?: YES

Warrant Satisfied?: YES

% Right Turns Included: 50

TRAFFIC SIGNAL WARRANTS ANALYSIS FORM

Sheet 2

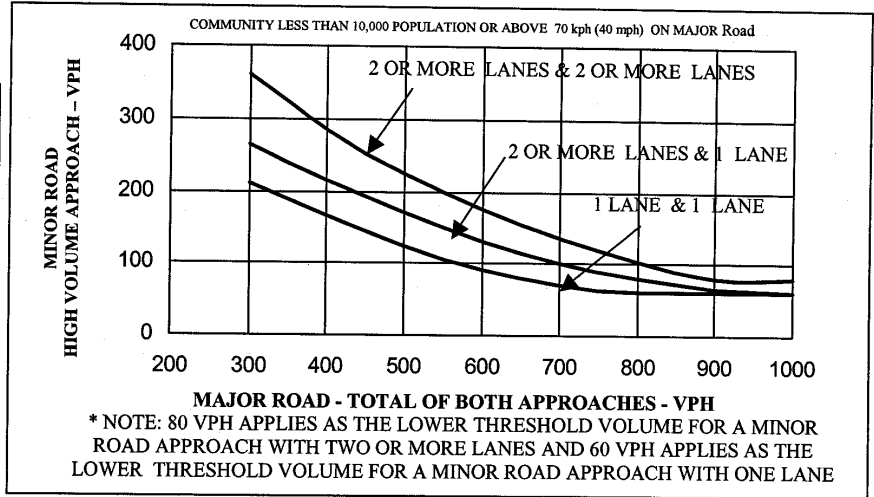
Warrant 2 – Four-Hour Vehicular Volume

Plot four volume combinations on the applicable figure below. If four points lie above the appropriate line, then the warrant is satisfied.

Figure A. Criteria for “70%” volume level.

Hour	5-6p	4-5p	3-4p	7-8a
Major Vol.	1680	1460	1345	1189
Minor Vol.	232	227	214	224

Satisfied?: YES



Warrant 3 – Peak Hour

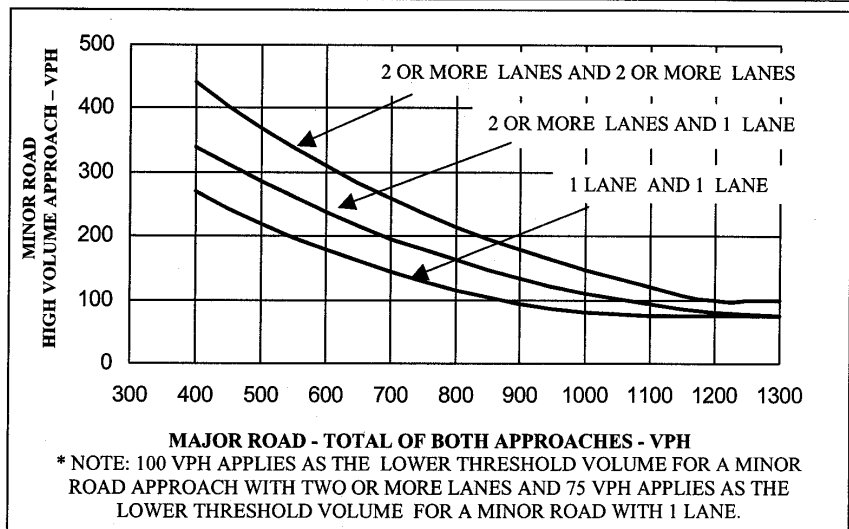
Unusual condition justifying use of warrant: _____
 Record hour where criteria are fulfilled and the corresponding delay or volume in boxes provided. Plot the peak hour volume combination on the applicable figure below. If all three criteria are fulfilled or the plotted point lies above the appropriate line, then the warrant is satisfied.

Criteria	Approach Lanes		No. of Approaches		Hour	Fulfilled?	
	1	2	3	4		Yes	No
1. Delay on Minor Approach (veh-h)	4	5				<input type="checkbox"/>	<input type="checkbox"/>
2. Volume on Minor Approach (veh/h)	100	150				<input type="checkbox"/>	<input type="checkbox"/>
3. Total Entering Volume (veh/h)			650	800		<input type="checkbox"/>	<input type="checkbox"/>

Figure A. Criteria for “70%” volume level.

Hour	5-6p
Major Vol.	1680
Minor Vol.	232

Satisfied?: NOT-EVALUATED



TRAFFIC SIGNAL WARRANTS ANALYSIS FORM

Sheet 3

Warrant 4 – Pedestrian Volume

Record hours where criteria are fulfilled and the corresponding volume or gap frequency in the boxes provided.
The warrant is satisfied if all three of the criteria are fulfilled.

Criteria	Hour				Fulfilled?	
					Yes	No
1. Pedestrian volume crossing the major road is 100 ped/h or more for each of any four hours or is 190 ped/h or more during any one hour.	Volume				<input type="checkbox"/>	<input checked="" type="checkbox"/>
2. There are less than 60 gaps per hour in the major road traffic stream of adequate length for pedestrians to cross during the same hours as the pedestrian volume criterion is satisfied.	GAPS				<input type="checkbox"/>	<input checked="" type="checkbox"/>
3. The nearest traffic signal along the major road is located more than 300 ft away. Or, the nearest traffic signal is within 300 ft but the proposed traffic signal will not restrict the progressive movement of traffic.					<input type="checkbox"/>	<input checked="" type="checkbox"/>

Satisfied?: NO

Warrant 5 – School Crossing

Record hours where criteria are fulfilled and the corresponding volume or gap frequency in the boxes provided.
The warrant is satisfied if all three of the criteria are fulfilled.

Criteria	Fulfilled?	
	Yes	No
1. There are a minimum of 20 students during the highest crossing hour.	<input type="checkbox"/>	<input checked="" type="checkbox"/>
2. There are fewer adequate gaps in the major road traffic stream during the period when the children are using the crossing than the number of minutes in the same period.	<input type="checkbox"/>	<input checked="" type="checkbox"/>
3. The nearest traffic signal along the major road is located more than 300 ft away. Or, the nearest traffic signal is within 300 ft but the proposed traffic signal will not restrict the progressive movement of traffic.	<input type="checkbox"/>	<input checked="" type="checkbox"/>

Satisfied?: NO

Warrant 6 – Coordinated Signal System

Indicate if the criteria are fulfilled in the boxes provided. The warrant is satisfied if either criterion is fulfilled. This warrant should not be applied when the resulting signal spacing would be less than 300 m (1000 ft).

Criteria	Fulfilled?	
	Yes	No
1. On a one-way road or a road that has traffic predominantly in one direction, the adjacent signals are so far apart that they do not provide the necessary degree of vehicle platooning.	<input type="checkbox"/>	<input checked="" type="checkbox"/>
2. On a two-way road, adjacent signals do not provide the necessary degree of platooning and the proposed, adjacent signals will collectively provide a progressive operation.	<input type="checkbox"/>	<input checked="" type="checkbox"/>

Satisfied?: NO

TRAFFIC SIGNAL WARRANTS ANALYSIS FORM

Sheet 4

Warrant 7 – Crash Experience

8 Highest Hours								
Hour	5-6p	4-5p	3-4p	7-8a	6-7p	6-7a	7-8p	8-9a
Major Road - Both App. vph	1680	1460	1345	1189	1173	1051	933	845
Minor Road High App. vph	232	227	214	224	198	250	162	186

Table 1: 80% Volume Comparison Criteria

(Volumes in veh/h)		Minimum Requirements			
Approach Lanes:		1		2 or more	
Volume Level:		80%	Hours	80%	Hours
Major Road Both App. vph	1A	280	16	335	
	1B	420	16	505	
Minor Road High App. vph	1A	85	8	110	
	1B	40	9	55	

Record hours where criteria are fulfilled, the corresponding volume, and other information in the boxes provided. The warrant is satisfied if all three of the criteria are fulfilled.

Criteria (Must use 80% - Urban - Condition Warrant Volume Levels)		Hour				Met?		Fulfilled?	
						Yes	No	Yes	No
1. One of the warrants to the right is met.	Warrant 4.1 is 80% of volume requirements: 56 ped/h for 4 hrs or 106 ped/h for 1 hr					<input type="checkbox"/>	<input checked="" type="checkbox"/>		
	Warrant 1, Condition A (80% satisfied from Table 1 above)					<input checked="" type="checkbox"/>	<input type="checkbox"/>		
	Warrant 1, Condition B (80% satisfied from Table 1 above)					<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
2. Adequate trial of other remedial measures has failed to reduce crash frequency.		Measures tried:						<input checked="" type="checkbox"/>	<input type="checkbox"/>
3. Five or more reported crashes, of types susceptible to correction by signal, have occurred within a 12-mo. Period.		Number of crashes per 12 months:						<input checked="" type="checkbox"/>	<input type="checkbox"/>

Warrant Satisfied?: YES

TRAFFIC SIGNAL WARRANTS ANALYSIS FORM

Sheet 5

Warrant 8 – Roadway Network

Record hours where criteria are fulfilled, the corresponding volume, and other information in the boxes provided. The warrant is satisfied if at least one of the criteria is fulfilled and if all intersecting routes have one or more of the characteristics listed.

Criteria						Met?		Fulfilled?	
						Yes	No	Yes	No
1. Both of the criteria to the right are met.	a. Total entering volume of at least 1,000 veh/h during typical weekday peak hour.		Entering volume:			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	b. Five-year projected volumes that satisfy one or more of Warrants 1, 2, or 3.		Warrant(s) satisfied:			<input type="checkbox"/>	<input type="checkbox"/>		
2. Total entering volume at least 1,000 veh/h for each of any 5 hrs of a non-normal business day (Sat. or Sun.)							-Hr.	<input type="checkbox"/>	<input type="checkbox"/>
							-Vol.		
Characteristics of Major Routes								Fulfilled?	
								Yes	No
								1. Part of the road or highway system that serves as the principal roadway network for through traffic flow.	
2. Rural or suburban highway outside of, entering, or traversing a city.								<input type="checkbox"/>	<input type="checkbox"/>
3. Appears as a major route on an official plan.								<input type="checkbox"/>	<input type="checkbox"/>

Warrant Satisfied?: NOT-EVALUATED

Left Turn Conflict Analysis

Criteria								
(Condition satisfied when the product of the mainline left turns in one direction and the opposing traffic exceed the thresholds given. NOTE: This is not a signal warrant.)								
No. of Left Turn Lanes	A		B		Product of peak left turning vehicles (A) and opposing plus right turn vehicles (B).		Exceeded?	
	Peak Volume Left Turns	No. of Opposing Lanes	Peak Opposing Volume in Same Hour	A x B	Threshold	Yes		
1		1		0	80,000	<input type="checkbox"/>	<input type="checkbox"/>	
1		2		0	100,000	<input type="checkbox"/>	<input type="checkbox"/>	

Condition Satisfied?: NOT-EVALUATED

CONCLUSIONS:

HCM Signalized Intersection Capacity Analysis
3: CTH YY & STH XX

6/1/2005



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑			↑		↖	↗		↖	↗	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Util. Factor		1.00			1.00		1.00	1.00		1.00	1.00	
Frt		0.96			0.94		1.00	1.00		1.00	0.98	
Flt Protected		0.98			0.99		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1766			1748		1770	1758		1770	1742	
Flt Permitted		0.90			0.95		0.16	1.00		0.33	1.00	
Satd. Flow (perm)		1609			1672		290	1758		621	1742	
Volume (vph)	30	34	23	20	66	59	42	618	6	92	827	95
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	32	36	24	21	69	62	44	651	6	97	871	100
RTOR Reduction (vph)	0	19	0	0	49	0	0	0	0	0	5	0
Lane Group Flow (vph)	0	73	0	0	103	0	44	657	0	97	966	0
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	8%	2%	2%	8%	2%
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		8.2			8.2		30.1	30.1		30.1	30.1	
Effective Green, g (s)		10.2			10.2		32.1	32.1		32.1	32.1	
Actuated g/C Ratio		0.21			0.21		0.66	0.66		0.66	0.66	
Clearance Time (s)		5.0			5.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		340			353		193	1168		413	1158	
v/s Ratio Prot								0.37			c0.55	
v/s Ratio Perm		0.05			c0.06		0.15			0.16		
v/c Ratio		0.21			0.29		0.23	0.56		0.23	0.83	
Uniform Delay, d1		15.7			16.0		3.2	4.3		3.2	6.1	
Progression Factor		1.00			1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		0.3			0.5		0.6	0.6		0.3	5.3	
Delay (s)		16.1			16.5		3.8	5.0		3.5	11.4	
Level of Service		B			B		A	A		A	B	
Approach Delay (s)		16.1			16.5			4.9			10.7	
Approach LOS		B			B			A			B	
Intersection Summary												
HCM Average Control Delay		9.4		HCM Level of Service		A						
HCM Volume to Capacity ratio		0.70										
Actuated Cycle Length (s)		48.3		Sum of lost time (s)		6.0						
Intersection Capacity Utilization		72.6%		ICU Level of Service		C						
Analysis Period (min)		15										

c Critical Lane Group

Lanes, Volumes, Timings
3: CTH YY & STH XX

6/1/2005



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑			↑		↖	↗		↖	↗	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	250		250	250		250	200		0	200		0
Storage Lanes	0		0	0		0	1		0	1		0
Total Lost Time (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Leading Detector (ft)	0	0		0	0		0	0		0	0	
Trailing Detector (ft)	0	0		0	0		0	0		0	0	
Turning Speed (mph)	15		9	15		9	15		9	15		9
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt		0.965			0.945			0.999			0.985	
Flt Protected		0.983			0.993		0.950			0.950		
Satd. Flow (prot)	0	1767	0	0	1748	0	1770	1758	0	1770	1743	0
Flt Permitted		0.889			0.963		0.125			0.245		
Satd. Flow (perm)	0	1598	0	0	1695	0	233	1758	0	456	1743	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		24			62			1			15	
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Link Speed (mph)		45			45			45			45	
Link Distance (ft)		1000			1000			1000			1000	
Travel Time (s)		15.2			15.2			15.2			15.2	
Volume (vph)	30	34	23	20	66	59	42	618	6	92	827	95
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	8%	2%	2%	8%	2%
Adj. Flow (vph)	32	36	24	21	69	62	44	651	6	97	871	100
Lane Group Flow (vph)	0	92	0	0	152	0	44	657	0	97	971	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Detector Phases	2	2		6	6		8	8		4	4	
Minimum Initial (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Minimum Split (s)	15.0	15.0		15.0	15.0		10.0	10.0		20.0	20.0	
Total Split (s)	25.0	25.0	0.0	25.0	25.0	0.0	35.0	35.0	0.0	35.0	35.0	0.0
Total Split (%)	41.7%	41.7%	0.0%	41.7%	41.7%	0.0%	58.3%	58.3%	0.0%	58.3%	58.3%	0.0%
Maximum Green (s)	20.0	20.0		20.0	20.0		30.0	30.0		30.0	30.0	
Yellow Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
All-Red Time (s)	1.0	1.0		1.0	1.0		1.0	1.0		1.0	1.0	
Lead/Lag												
Lead-Lag Optimize?												
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Minimum Gap (s)	2.0	2.0		2.0	2.0		2.0	2.0		2.0	2.0	
Time Before Reduce (s)	10.0	10.0		10.0	10.0		15.0	15.0		15.0	15.0	
Time To Reduce (s)	10.0	10.0		10.0	10.0		10.0	10.0		10.0	10.0	
Recall Mode	Min	Min		Min	Min		Min	Min		Min	Min	
Act Effct Green (s)		10.2			10.2		32.1	32.1		32.1	32.1	
Actuated g/C Ratio		0.21			0.21		0.66	0.66		0.66	0.66	
v/c Ratio		0.26			0.37		0.28	0.56		0.32	0.83	
Control Delay		13.0			11.3		10.2	7.3		7.8	16.4	
Queue Delay		0.0			0.0		0.0	0.0		0.0	0.0	
Total Delay		13.0			11.3		10.2	7.3		7.8	16.4	

5:00 pm Baseline
Wisconsin DOT

Synchro 6 Report
Page 1

Lanes, Volumes, Timings
3: CTH YY & STH XX

6/1/2005

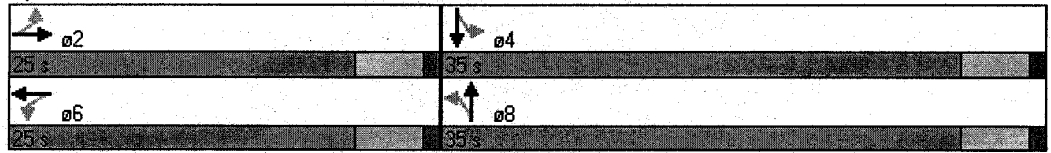


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
LOS		B			B		B	A		A	B	
Approach Delay		13.0			11.3			7.4			15.6	
Approach LOS		B			B			A			B	
Queue Length 50th (ft)		16			21		4	72		8	148	
Queue Length 95th (ft)		44			58		25	183		38	#484	
Internal Link Dist (ft)		920			920			920			920	
Turn Bay Length (ft)							200			200		
Base Capacity (vph)		601			661		155	1168		303	1163	
Starvation Cap Reductn		0			0		0	0		0	0	
Spillback Cap Reductn		0			0		0	0		0	0	
Storage Cap Reductn		0			0		0	0		0	0	
Reduced v/c Ratio		0.15			0.23		0.28	0.56		0.32	0.83	

Intersection Summary

Area Type: Other
 Cycle Length: 60
 Actuated Cycle Length: 48.3
 Natural Cycle: 60
 Control Type: Actuated-Uncoordinated
 Maximum v/c Ratio: 0.83
 Intersection Signal Delay: 12.3 Intersection LOS: B
 Intersection Capacity Utilization 72.6% ICU Level of Service C
 Analysis Period (min) 15
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.

Splits and Phases: 3: CTH YY & STH XX



APPENDIX IV – CRASH REPORTS

Yr 2000 - 2003
 STH XX & CTH YY
 Town of ABC
 County XXXXXX

M U N I C I P A L I T Y	R O A D	S I D E	S T R E E T	D A T E	W E A T H E R	L I G H T	V I S I B I L I T Y	A C C I D E N T	M O V E M E N T	R O A D	T R A F F I C	S I G N A L	W O R K	W H E N	W H E R E	W H A T	W H O	W H E R E	W H E N	W H E R E	W H A T	W H O	
ABC ON	XX MAINLINE RD	E	122	0.71	000	YY	SIDESTREET ST	MON	13	04/04/00	N	REAR	2	REAR	2	REAR	2	REAR	2	REAR	2	REAR	2
ABC ON	XX MAINLINE RD	E	122	0.71	000	YY	SIDESTREET ST	SAT	13	09/09/00	N	SSS	2	SSS	2	SSS	2	SSS	2	SSS	2	SSS	2
ABC ON	YY SIDESTREET ST	N	122	0.71	000	XX	MAINLINE RD	TUE	13	12/28/00	N	REAR	2	REAR	2	REAR	2	REAR	2	REAR	2	REAR	2
ABC ON	YY SIDESTREET ST	N	122	0.71	000	XX	MAINLINE RD	THU	17	06/20/01	N	REAR	2	REAR	2	REAR	2	REAR	2	REAR	2	REAR	2
ABC ON	XX MAINLINE RD	E	122	0.71	000	YY	SIDESTREET ST	WED	10	01/15/02	N	SNOW		SNOW		SNOW		SNOW		SNOW		SNOW	
ABC RTRH	XX MAINLINE RD	E	122	0.73	N	002		FRI	23	04/10/02	Y	DARK		DARK		DARK		DARK		DARK		DARK	
ABC ON	XX MAINLINE RD	E	122	0.71	000	YY	SIDESTREET ST	THU	9	02/11/02	N	WET		WET		WET		WET		WET		WET	
ABC RTRH	XX MAINLINE RD	E	122	0.70	N	001		SUN	20	11/05/01	N	ICE		ICE		ICE		ICE		ICE		ICE	
ABC RTRH	XX MAINLINE RD	E	422	0.67	N	004		SUN	20	09/06/02	N	DARK		DARK		DARK		DARK		DARK		DARK	
ABC ON	XX MAINLINE RD	E	122	0.71	000	YY	SIDESTREET ST	FRI	8	01/31/03	N	SNOW		SNOW		SNOW		SNOW		SNOW		SNOW	
ABC ON	XX MAINLINE RD	E	122	0.71	000	YY	SIDESTREET ST	TUE	16	06/24/03	N												

APPENDIX V – COLLISION DIAGRAM (OPTIONAL)

